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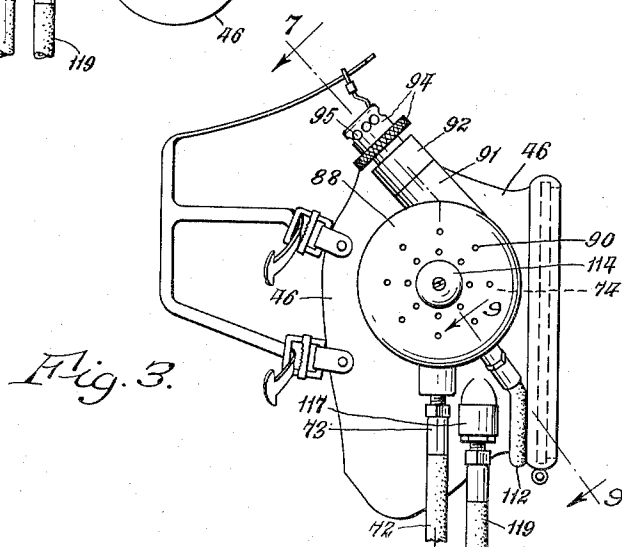
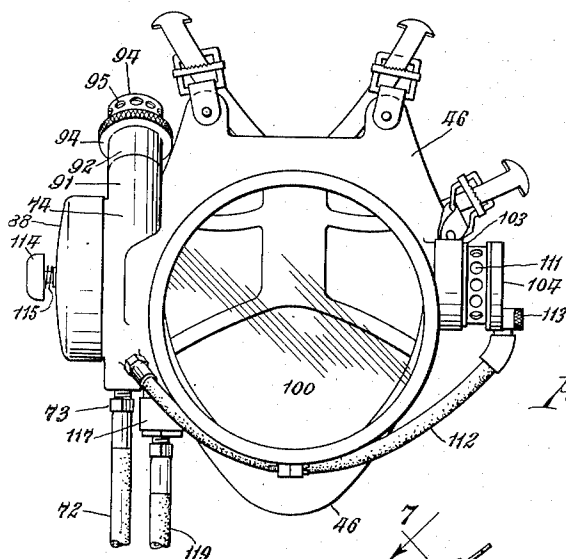
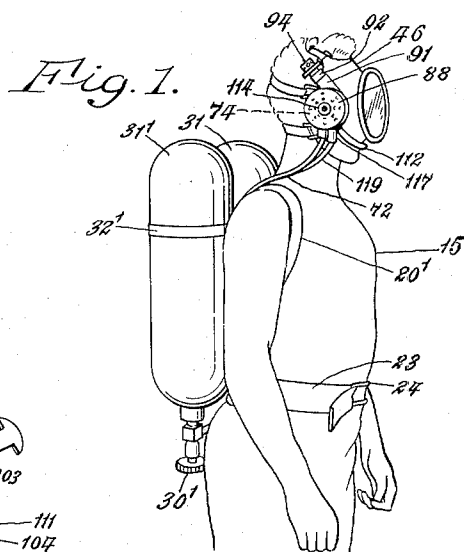
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2,764,151

UNDERWATER BREATHING APPARATUS

Filed June 16, 1953

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

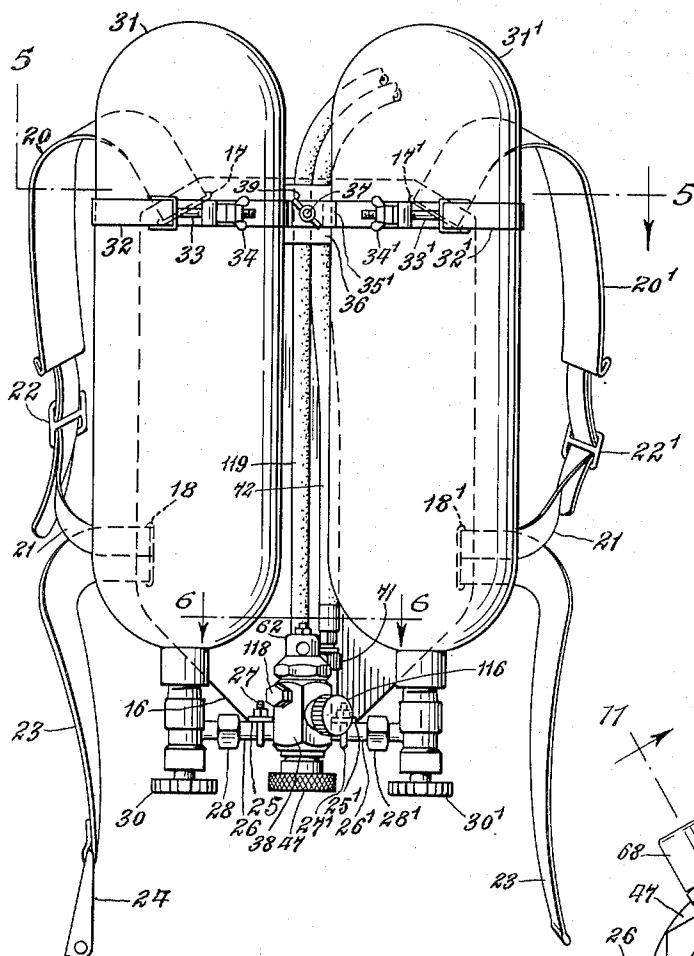


Fig. 4.

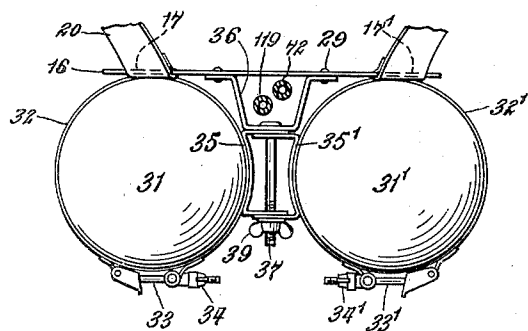


Fig. 5.

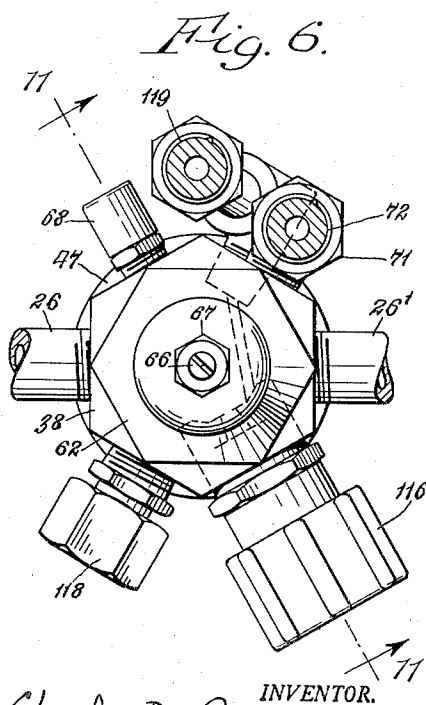


Fig. 6.

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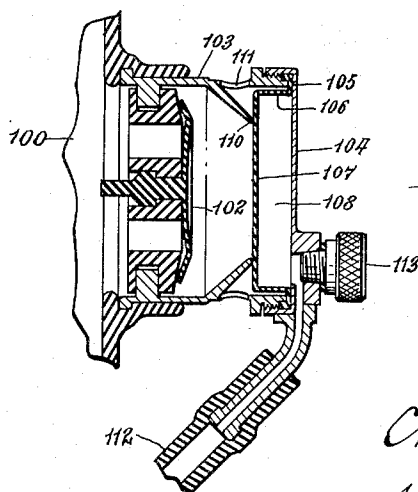
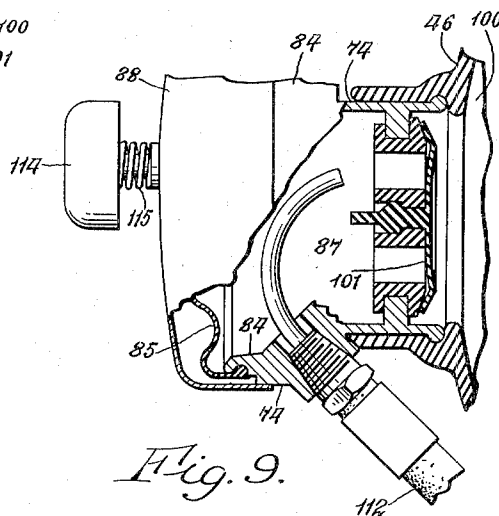
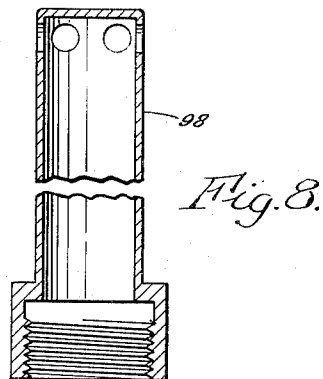
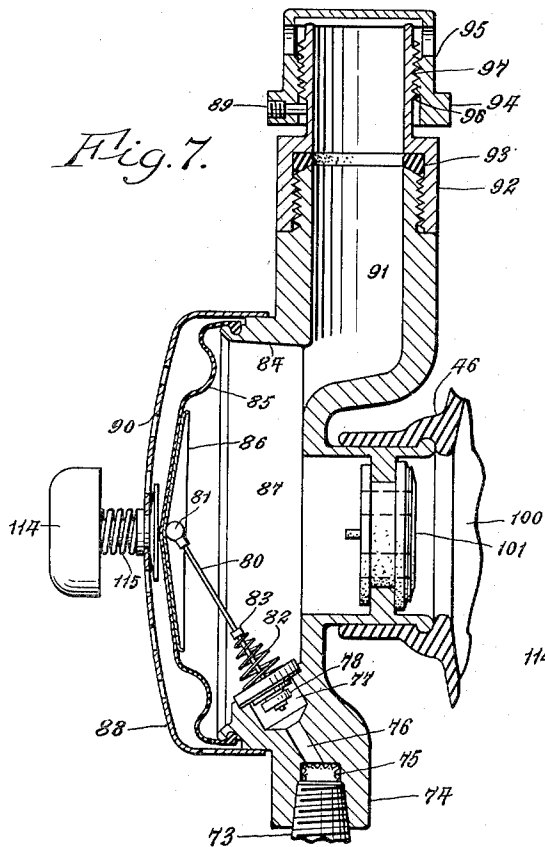
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UNDERWATER BREATHING APPARATUS

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4 Sheets-Sheet 3



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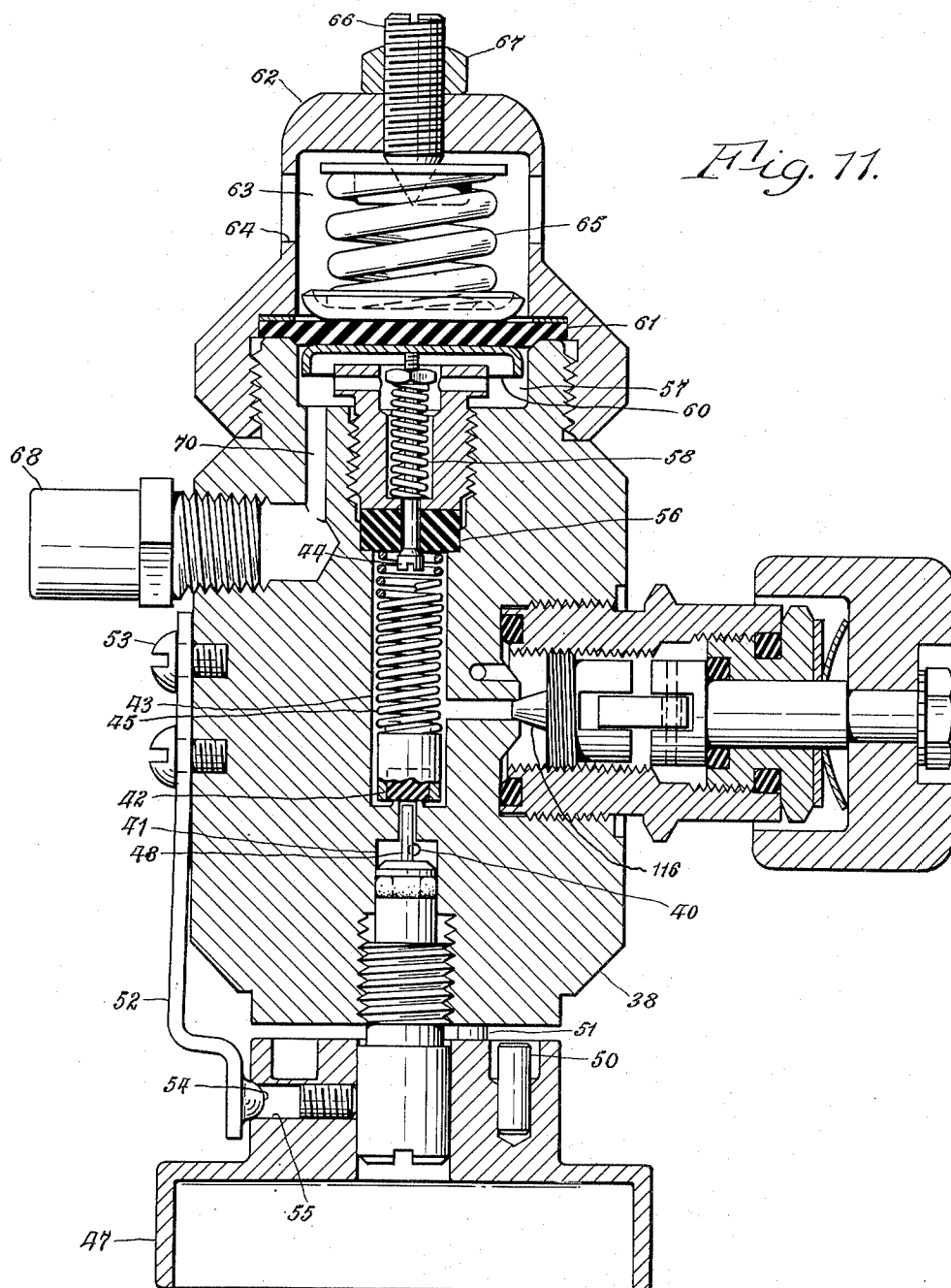
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UNDERWATER BREATHING APPARATUS

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4-Sheets-Sheet 4



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2,764,151

UNDERWATER BREATHING APPARATUS

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Application June 16, 1953, Serial No. 362,065

12 Claims. (Cl. 128—142)

This invention relates to an underwater breathing apparatus, and relates, more particularly, to a portable, self-contained, breathing apparatus which, when under water, employs compressed air as the inhaled breathing fluid, with the foul, exhaled, breathing fluid being discharged into the water through an exhalation valve.

The invention is preferably of the type which includes a full-face, underwater mask and a demand valve, but the invention is not necessarily confined to a breathing apparatus which includes these elements.

The principal objects of the invention are to provide a portable, self-contained breathing apparatus—

1. Which will permit of being completely donned above water, but which will also permit the diver, in an emergency, to instantly submerge himself without necessitating any preliminary adjustment to the breathing apparatus.

2. Which will prevent any uneconomic loss of breathing fluid irrespective of the relative position of the various parts of the body of the diver or their relationship to the various parts of the breathing apparatus.

3. Which will enable the diver to put on his mask under water, and to instantly discharge from his mask any water which may be contained therein, whether he be above or below water.

4. Which will enable the diver to know when he is down to his reserve air supply, and to do this without having to look at any dial or to feel anything with his fingers.

5. Which will provide the diver with compressed air at progressively higher pressures as he descends to greater depths and as, concomitantly, the resistance to exhalation increases.

6. Which will permit of the use of a demand valve, so that air will only be fed to the diver when he is inhaling, and will be fed to him in pressure and volume in automatic accordance with his breathing rate and duration of each of his breathing cycles.

7. Which will permit the use of a snorkel air inlet duct so that he may submerge himself to a considerable depth and for an indefinite length of time without breathing in anything but ambient air, and yet will automatically feed him compressed air and prevent any considerable flow of water into the snorkel if he should submerge himself beyond the maximum depth at which the snorkel is able to function.

8. Which will enable the diver to most quickly and conveniently remove, or put in place, one or both of the compressed-air, storage tanks.

9. Which, alternatively, will permit said compressed-air, storage tanks to be charged with compressed air, when desired, without removing them from the back plate that detachably holds them on the diver's back.

10. Which, in a most simple and light-weight manner, will enable said compressed-air, storage tanks to be stanchly secured to said back plate, without interfering with the ease with which said tanks may be removed or replaced in position.

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Other collateral objects of the invention and practical attainments thereof are described in the accompanying detailed description of one form of the invention and illustrated in the appended drawings, wherein:

5 Fig. 1 is a diminutive, perspective view of a diver equipped with an underwater breathing apparatus constructed in accordance with the present invention.

Fig. 2 is a front elevation of the mask and its appurtenances.

10 Fig. 3 is a side view of said mask.

Fig. 4 is a rear elevation of the back plate with its retaining straps and belt in place, and with also the two compressed-air storage tanks, etc., in place.

Fig. 5 is a top plan of the back plate and its attachments shown in Fig. 4.

Fig. 6 is an enlarged, horizontal section taken just above the reduction valve on line 6—6 Fig. 4.

Fig. 7 is an enlarged, fragmentary, substantially vertical, transverse section through the mask taking on line 20 7—7 Fig. 3.

Fig. 8 is an enlarged, vertical, longitudinal section through a snorkel attachment, which may be used instead of the regular air inlet duct fitting.

Fig. 9 is an enlarged, fragmentary, inclined section through the inlet portion of the mask taken on line 9—9 Fig. 3.

Fig. 10 is an enlarged, fragmentary, inclined section taken on approximately the same inclined line as Fig. 4, but taken through the left side of the mask through the 30 exhalation valve and its appurtenances.

Fig. 11 is a greatly enlarged, vertical, longitudinal section through the reduction valve on line 11—11 Fig. 6.

Similar characters of reference indicate like parts in the several figures of the drawings.

35 The "frogman" or diver 15, shown in Fig. 1 has detachably secured to his back a flat, substantially rectangular back plate 16. This back plate is provided at its upper corners with a pair of upper openings 17 and 17' and at its lower corners with a pair of lower openings 18 and 18'. Passing through said upper openings 17, 17', and attached by their bights at their upper ends to said back plate (see Figs. 5 and 4) are a pair of flexible shoulder straps 20 and 20'. Passing through the lower openings 18, 18' of the back plate 16 is a hold-down strap 21 45 whose opposite ends are adjustably connected with the lower ends of aforesaid shoulder straps 20, 20'—the adjustment being effected by the usual "slides" 22, 22'. This comfortably supports the whole back plate 16 and its appurtenances upon the shoulders of the diver, when he is walking, and holds the upper parts of said back plate firmly in position when he is swimming. The lower part of said back plate 16 is held firmly against the small of the back of the diver (both on land and when he is swimming) by a belt 23 which passes through the same 55 lower openings 18, 18' as the hold-down strap 21. One end of this belt is provided with the usual belt buckle 24.

The extreme lower part of the back plate 16 is of truncated, triangular form, terminating at its extreme lower end in a pair of rearwardly-bent, integral, symmetrically-disposed supporting spuds or ears 25, 25', against the 60 lower faces of which is clamped a pair of short nipples or breathing-fluid pipes 26, 26'. The clamping is effected by a pair of U bolts 27, 27', each of whose bights embraces the lower face of the adjacent portion of its companion breathing pipe 26 or 26', while the upwardly-extending, threaded tangs or shanks of said U bolts pass through suitable holes drilled in the ears 25, 25' and are clamped in place by suitable nuts which engage the upper 65 faces of said ears 25, 25'.

The outer end of each breathing pipe 26, 26' is provided with a detachable union or coupling 28, 28' whose 70 outer parts are connected to the casings of the shut-off

valves 30, 30'. Each of these valves is secured to the lower end of a cylindrical companion storage tank 31, 31' whose upper end is embraced by a companion flexible band 32 or 32'. The opposite ends of each of these flexible bands are adapted either to be opened up and separated from each other or to be clamped together by companion clamp screws 33, 33', whose outer ends are pivotally connected to the outer ends of their companion flexible bands 32 or 32' while the inner ends of said clamp screws are detachably clamped to the inner ends of their companion flexible bands 32 or 32' by wing nuts 34, 34', in a manner well known in the art.

The inner portion of each flexible band 32, 32' (see Figs. 4 and 5) is secured, by riveting or otherwise, to a sheet-metal, bifurcated cleat 35, 35'. Secured to the back plate 16, as by rivets 29, is a hollow or channel-shaped, sheet-metal bracket 36, and through the medial point of said bracket passes a clamping bolt 37 which also passes through both ears of each of the bifurcated cleats 35, 35'. This arrangement firmly holds either or both of the flexible bands 32, 32' to the back plate 16 and, as each of said flexible bands is adapted to detachably clasp the upper end of a companion storage tank 31, 31', it follows that the upper end of either one or the upper ends of both of said storage tanks are detachably secured to the upper part of the back plate 16. This construction also permits the using of storage tanks of widely varying diameters—this being taken care of both by the wing nuts 34, 34' and the wing nut 39 of clamping bolt 37.

The inner ends of aforesaid breathing-fluid pipes 26, 26' are screwed into a pressure-reducing valve casing 38 (see Figs. 4, 6, and 11). The compressed air in the storage tanks 31, 31' passes through either one or both of their shut-off valves 30, 30'—couplings 28, 28'—and breathing-fluid pipes 26, 26' and into the holes 40 of the pressure-reducing valve casing 38, and thence into a coaxially-located, cylindrical, inlet chamber 41. The pressure of the compressed air in this inlet chamber 41 is the same as the pressure supplied by either the one or other or both of the storage tanks 31, 31'. When this pressure is relatively high it is able to move upwardly past the spring loaded check valve 42 and thence into an intermediate pressure chamber 43 which feeds a pressure-reducing valve 44.

For simplicity of explanation, let us now assume that both storage tank valves 30 and 30' are open and that both of their companion storage tanks 31 and 31' are fully charged with compressed air or other breathing fluid.

As will be described in detail later, the opening and closing of the pressure-reducing valve 44 is partially dependent upon the pressure existing in the intermediate chamber 43. It follows from this that, when the pressure in this intermediate chamber 43 falls sufficiently far, due to the almost complete evacuation of the storage tanks 31 and 31' plus the action of the compression spring 45 of the check valve 42, no more air will flow past the pressure reducing valve 44 to the diver's breathing mask or face mask 46.

This shutting off of the air supply will automatically notify him that he is down to the reserve supply of air in the storage tanks and this notification to him will operate without his having to frequently glance at or to manually feel a pressure gauge—either of these operations being particularly inconvenient when the diver is under water. Upon being thus notified that he is down to the reserve supply of compressed air in the storage tanks 31, 31' he turns the knob 47 of the check-valve unseating pin 48, thereupon causing the check valve 42 to be unseated thereby providing him with the reserve supply of air in the air storage tanks.

Excessive upward movement of the unseating pin 48 is prevented by a stop pin 50 on knob 47 which pin is adapted to strike an abutment pin 51 that extends downwardly from the lower face of the pressure-reducing valve

casing 38. Thus, said knob 47 has two operative positions and it is held in the one or other of these two operative positions by a sheet-metal, resilient, detent arm 52 which is secured to the pressure-reducing casing 38 by cap screws 53 and is provided at its extreme lower end with an integral, pressed-out, semispherical, detaining tongue 54 which is adapted resiliently to engage with one or the other of a pair of detent holes 55 formed radially in the hub of the knob 47 (only one of these holes 55 is illustrated).

The stem of the pressure-reducing valve 44 is a loose fit in its nylon or rubber, annular, valve seat 56 so the compressed air in the intermediate chamber 43 is always free to flow up into the outlet end of the casing 38 and into the outlet chamber 57 whenever said pressure-reducing valve 44 is pushed downwardly against the resistance of its compression spring 58. Such pushing down is effected by a sheet metal, flanged disk 60 which lies against the lower face of a rubber or other resilient diaphragm 61. The latter is clamped between the upper end face of the pressure-reducing casing 38 and the downwardly facing shoulder of a threaded cap 62, whose hollow interior may be termed an ambient chamber 63 because of the openings 64 in the side walls of said cap 62.

Within said ambient chamber 63 is a vertical compression spring 65 which is adjusted by a co-axial adjustment screw 66 that is threaded through the upper or end wall of the cap 62, and is locked in proper adjusted position by a lock nut 67. This compression spring 65 is much stronger than the light compression spring 58 of the pressure-reducing valve 44 and hence tends to hold said valve 44 open until a certain pressure has been built up in the outlet chamber 63 which pressure counteracts said compression spring 65. This compression spring 65 does not, however, act independently of all other forces, because the upper face of the diaphragm 61 is also pressed downwardly by whatever pressure exists in the ambient chamber 63. The advantages of this arrangement cannot be properly described until the mask 46 and its appurtenances have been described in detail. In general, however, it may be said that the pressure in this ambient chamber 63 is always substantially the same as the pressure of the ambient fluid surrounding the mask 46. It is true that when the diver is above water and is standing up, as in Fig. 1, this mask 46 is located some distance above the ambient chamber 63, but the difference in atmospheric pressures at the two points is obviously negligible. And, when the diver is swimming in the water, his trunk is substantially horizontal, so that the ambient chamber 63 is at substantially the same distance below the surface of the water as the mask 46. And, when he swims down to greater depths in the water, the pressure in the ambient chamber and the pressure of the water surrounding the mask both increase in direct proportion to their depths below the surface of the water.

Any excessive pressure in the outlet chamber 57 is relieved by a safety valve 68 which communicates with said outlet chamber 57 through a suitable drilled hole 70.

The outlet chamber 57 communicates with a coupling 71 which is mounted at the lower end of flexible, breathing-fluid, supply tube 72. This tube extends upwardly between the air storage tanks 31, 31', and through the hollow interior of the hollow bracket 36 (see Fig. 5). This prevents this portion of said tube from getting tangled up with the diver or with other parts of his breathing apparatus. This breathing-fluid tube 72 passes upwardly and forwardly over the right shoulder of the diver (see Fig. 1) and to a terminal, tube fitting 73 which is screwed into the lower central face of the casing of a regulator 74. This terminal tube fitting 73 (see Fig. 7) communicates through a protective screen 75 with a hole 76 which is drilled in the regulator 74 diagonally downwardly from a demand-valve compartment 77 in which is situated a tiltable, demand valve 78 that is provided with an upwardly and outwardly extending valve stem 80 terminating in a ball end 81. This demand valve is provided with a co-axial, conical

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spring 82 which is connected to the valve stem 80 at 83, and which resiliently urges the demand valve 78 toward its non-tilted, closed position as shown in Fig. 7.

The regulator 74 is provided with an annular rim 84 whose outer end is covered by a flexible diaphragm 85 having a sheet-metal, conical, pressure-dispersing plate 86 cemented concentrically to its inner face. This conical plate 86 makes contact with the ball end 81 of the demand valve stem 80, so that, when the diaphragm 85 is pushed inwardly by the ambient air or water pressure on its outer face, a diagonal thrust is imposed upon the stem 80 of the demand valve 78 and the latter is opened. This permits the compressed air to pass from the demand valve compartment 77 up into the inlet chamber 87 of the mask 46. Said diaphragm 85 is protected on its outer face by a sheet-metal, disked cover 88 which is provided with a plurality of holes 90 to allow the pressure of the surrounding ambient fluid to be exerted upon the outer face of the diaphragm 85, and also to drain out all water from the interior of said cover 88 when the diver emerges from the water.

Projecting upwardly and rearwardly from the regulator 74 is an integral, air inlet duct 91 upon whose upper end is threaded a tubular sleeve 92 which has a water-tight fit upon said air inlet duct by virtue of a compressed O-ring 93. Threaded upon the upper end of said sleeve 92 is a cap or air economizer valve 94 provided on its upper periphery with a plurality of air-inlet openings 95. Said economizer valve 94 is adapted to be screwed up or down to either allow air to come in through said air-inlet openings 95, or to prevent the admission of water through said air inlet openings. Excessive upward movement of the economizer valve 94 is prevented by a long nosed screw 89, the end of whose nose is adapted to come into contact with a downwardly facing shoulder 96 that is formed at the lower terminus of the male, threaded portion 97 of the sleeve 92.

In Fig. 7 this sleeve 92 is shown as being screwed up to almost its full extent. This is the normal position of said sleeve when the diver is above water for some time and desires to economize the air supply by avoiding any draining of air from the compressed-air, storage tanks 31, 31'. Under these circumstances ambient air freely enters the air inlet duct 91 and prevents any appreciable vacuum forming in the inlet chamber 87 of the mask 46. This prevents opening of the demand valve 78, and hence conserves or economizes the supply of compressed air in the air storage tanks 31, 31'.

If the diver desires to suddenly submerge himself (or falls overboard) without having time to close the economizer valve 94, the ambient water pressure pushes in the diaphragm 85 and causes the demand valve 78 to open. This builds up the air pressure in the inlet compartment 87 and thereby prevents any considerable amount of water entering through the air economizer valve 94. To absolutely prevent any ingress of water, the diver may, while still under water, close the air economizer valve 94. This is more particularly desirable if he desires to swim down to a considerable depth.

If on, the other hand, he desires to completely submerge himself under water and to at the same time conserve his supply of compressed air, he unscrews the sleeve 92 and replaces it with a somewhat longer snorkel tube 98 (Fig. 8). He then closes the air valves 30, 30', and completely submerges himself for an indefinite length of time, without using air from his storage tanks, and with nothing but the top of the snorkel showing above the surface of the water.

Between the central portion and breathing chamber 100 of the breathing mask 46 is an inlet check valve 101. This check valve permits air to be inhaled through the economizer valve 94 and into the breathing chamber 100, but prevents exhaled air from being vented from said breathing chamber 100 outwardly through said economizer valve 94. Such an inlet check valve in this location is believed to be distinctly new in the art inasmuch as it permits the proper functioning of an ambient air inlet into the inlet

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chamber 87 of the mask without in any way affecting the action of the demand valve when the flow of ambient air is cut off.

On the left side of the breathing mask 46 (see Fig. 10) is a main exhalation valve 102 for venting the foul air from the breathing chamber 100 of the breathing mask. The casing 103 of this main exhalation valve 102 extends out beyond said valve and is externally threaded at its outer end to receive a threaded cover 104, between which the outer end of the casing 103 is clamped the outwardly extending flange 105 of a cup-shaped, flexible, control, exhalation valve 106. The hollow space between the outside face of the main, vertical wall 107 of this control exhalation valve 106 and the inside of the cover 104 may be denominated an exhalation balancing chamber 108. The valve seat 110 of the control exhalation valve 106 has a diameter considerably less than the diameter of the main, vertical wall 107 of the control, exhalation valve 106. For this reason, the pressure of the foul air at the exit end of the main exhalation valve 102 must be greater than the air pressure in the exhalation, balancing chamber 108, before any foul air can flow past both valves (102 and 106), and pass out through the venting apertures 111 of the valve casing 103.

The pressure in the exhalation, balancing chamber 108 is always the same as the pressure in the inlet chamber 87 of the mask. This is because these two chambers are always in direct communication with each other through a flexible balancing tube 112, the right end (see Fig. 9) of which is curved upwardly and inwardly well above the floor of the inlet chamber 87 so as to minimize the chance of water getting into the balancing tube 112. If any appreciable amount of water should get into this tube, the diver removes same by putting the left side of his mask down and opening drain screw valve 113.

The principal reason for this balancing tube 112 and its appurtenances is to obtain a proper and efficient function of the various parts of the breathing apparatus when the diver is under water with his head turned sidewise with its right side down, i. e., with the regulator 74 of the mask down and the main exhalation valve casing 103 up. Under these conditions there is a relatively heavy water pressure on the outside of the diaphragm 85 and consequently a relatively high air pressure in the inlet chamber 87 of the breathing mask 46 and in its main breathing chamber 100. This, if not properly compensated for, would cause an excessive venting of air through the main exhalation valve 102. But the present invention compensates for this condition of affairs by increasing the air pressure in the exhalation balancing chamber 108 and thereby preventing any egress of air from the mask until the pressure in the breathing chamber 100 had risen to a point where it can be effectively used by the diver before being exhaled.

If, for any reason, an uncomfortable quantity of water should get into the breathing chamber 100 of the mask, the diver simply treads water momentarily, pushes in a water discharge knob 114, against the resistance of its spring 115 (see Fig. 7) and pulls the chin portion of his mask away from his chin. This pushing in of the knob 114 forces the demand valve 78 to open and hence raises the air pressure in the inlet chamber 87 and breathing chamber, thereby forcing out any "bilge" water as soon as the diver gives it a chance to escape by momentarily pulling out the chin portion of his mask.

If something should go wrong with the pressure reducing valve 44, or the breathing-fluid tube 72, or the demand valve 73, he merely opens the emergency valve 116 (Fig. 11) which allows compressed air to flow from the pressure-reducing-valve casing 33 up through an emergency, breathing-fluid tube 119 and directly into the breathing mask 46 through its emergency, air-inlet pocket 117 which (see Fig. 3) is located just below and forwardly of the regulator 74. The diver can also use this emergency valve 116 to force "bilge" water out of the mask

by momentarily opening said emergency valve and pulling the chin part of the mask away from his chin.

If he wants to recharge both storage tanks 31 and 31' with compressed air, without removing said tanks from the back plate 16, he merely connects the charging valve 118 (see Figs. 6 and 4) with a suitable source of compressed air.

I claim:

1. A portable breathing apparatus including a breathing mask or the like and comprising: a back plate having a pair of upper openings and a pair of lower openings; a pair of shoulder straps, each of which passes at its upper end through one of said upper openings and is connected with the back plate; a hold-down strap passing through both of said lower openings and adjustably connected at its opposite ends to the lower ends of said shoulder straps; a storage tank mounted on said back plate; and tubular means connecting said tank with the breathing mask.

2. As in claim 1 but with the addition of a belt passing also through the lower openings of the back plate.

3. A portable breathing apparatus including a breathing mask or the like comprising: a back plate having a supporting ear; a breathing-fluid pipe connected with said ear; a storage tank detachably connected at one end with said pipe; detachable means connecting the other end of said tank with the back plate; and means tubularly connecting said pipe with the breathing mask.

4. A portable breathing apparatus including a breathing mask or the like comprising: a back plate having a pair of connected to each of said ears; a storage tank detachably laterally projecting supporting ears; a breathing-fluid pipe connected at one end to each of said pipes; individual, detachable means connecting the other end of each of said tanks with the back plate; and means tubularly connecting both of said pipes with the breathing mask.

5. A portable breathing apparatus including a breathing mask or the like and comprising: a back plate bent at its lower end to form a laterally projecting integral ear; a breathing-fluid pipe lying against one face of said ear; a U bolt encircling said pipe and connecting said pipe with said ear; a storage tank detachably connected at one end with said pipe; detachable means connecting the other end of said tank with the back plate; and means tubularly connecting said pipe with the breathing mask.

6. A portable breathing apparatus including a breathing mask or the like and comprising: a back plate; a storage tank; a flexible band adapted to grip the periphery of said tank; a cleat connected with said band; means connecting said cleat with the back plate; and means tubularly connecting said tank with the breathing mask.

7. A portable breathing apparatus including a breathing mask or the like and comprising: a back plate having a hollow bracket; a storage tank; a flexible band adapted to grip the periphery of said tank; a cleat connected with said band; means connecting said cleat with the bracket; and a breathing-fluid tube connected with the tank and passing through the hollow interior of the bracket and conveying the breathing fluid to the breathing mask.

8. A portable breathing apparatus including a breathing mask or the like and comprising: a back plate; a pair of storage tanks; a flexible band adapted to grip the periphery of each of said tanks; a cleat connected with each of

said bands; a single detachable fastening means connecting both cleats with the back plate; and means tubularly connecting the tank with the breathing mask.

9. A portable breathing apparatus including a breathing mask or the like and comprising: a back plate; a pair of storage tanks; a flexible band adapted to grip the periphery of each of said tanks; a dual-armed cleat connected with each of said bands; a single fastening means connecting the arms of both cleats with the back plate; and means tubularly connecting the tanks to the breathing mask.

10. An underwater apparatus including a breathing mask or the like and comprising: a casing supplied with breathing fluid under pressure; a spring-loaded check valve arranged in said casing and resiliently urged to close against the flow of the breathing fluid; means adapted to positively unseat said check valve; a pressure-reducing valve communicating with the outlet end of said check valve; and a tubular connection between the outlet end of said pressure-reducing valve and the breathing mask.

11. An underwater breathing apparatus comprising: a mask having an inlet chamber and a breathing chamber; a demand valve in said inlet chamber actuated by a diaphragm whose outer surface is exposed to the pressure of the water at its particular water level; means for supplying said demand valve with breathing fluid; a check valve between said inlet chamber and said breathing chamber; a main exhalation valve adapted to vent the breathing chamber; and a control exhalation valve exposed on its one face to the outlet pressure of the main exhalation valve and exposed on its other face to the pressure of the inlet chamber.

12. An underwater breathing comprising: a mask having an inlet chamber and a breathing chamber; a demand valve in said inlet chamber actuated by a diaphragm whose outer surface is exposed to the pressure of the water at its particular water level; means for supplying said demand valve with breathing fluid; a check valve between said inlet chamber and said breathing chamber; a main exhalation valve adapted to vent the breathing chamber; an exhalation-balancing chamber; a control exhalation valve exposed on its one face to the outlet pressure of the main exhalation valve and on its other face to the pressure in said balancing chamber; and a tubular connection between said exhalation-balancing chamber and the inlet chamber, said tubular connection extending up above the floor of said inlet chamber.

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